

Instream treatment (e.g., woody debris, rootwads, boulders, side channels, pools, spawning gravel, nutrient augmentation), conversion to non-structural flood control (e.g., meander zones)

Instream Structures: Applications, Costs and Methods

CRAIG BELL

Trout Unlimited North Coast Coho Project
P.O. Box 1256
Gualala, CA 95445
acenlil@mcn.org

Session Four

ABSTRACT

The Trout Unlimited North Coast Coho Project is working to reestablish coho salmon refuges throughout Mendocino County. This work is an excellent example of the value of a cooperative program involving conservation timber interests and people dedicated to recovering commercial and recreational coho salmon fisheries. We have spent years placing habitat structures in streams, and this paper draws on that experience to discuss the planning, budgeting and implementation of instream structures. The development of cost estimates on a broader geographic scale is also considered.

INTRODUCTION

Stream restoration in California has been ongoing for about 25 years, and is referred to as an evolving art and science by its practitioners. While the current emphasis is correctly shifting to upslope erosion control, there is still a need to increase instream habitat complexity as part of a comprehensive watershed approach. Regulatory changes governing timber operations under Endangered Species Act listings, the Clean Water Act Total Maximum Daily Load Program, and the development of Habitat Conservation Plans seek to restore properly functioning riparian and instream habitat. Although restoring riparian habitats is crucial, it must be noted that once riparian zones in coniferous forests have been severely disturbed, natural recruitment of large wood in streams will not occur for over 60 years (Seddell *et al.* 1988). Seddell further states that in logged watersheds throughout the Pacific Northwest, large wood in streams has been reduced on average by 80–90%. The addition of instream habitat enhancement structures is vital to remedying this situation and ensuring that streams are able to support fish populations. Properly placed and constructed instream structures provide summer and winter juvenile rearing pool habitat, insect food production, storage and sorting of spawning gravels, bank protection, refuge from predators, and possible water cooling effects from forced sub-surface flows.

There is a wealth of information about designing and installing instream structures in the *California Salmonid Stream Habitat Restoration Manual* published by the California Department of Fish and Game (CDFG). The manual (Flosi *et al.* 1998) contains guidelines for structure placement, suitable materials, and fastening techniques. It also provides standardized budget formats for different types of restoration project. Additional information concerning standardized costs for construction can be found in the latest CDFG *Request For Proposals* (RFP) (CDFG 2000). These two documents are of invaluable help when developing a restoration projects and laying out all of its associated costs. Please refer to the References section of this paper for information about how to obtain both of these resources.

CALCULATING COSTS FOR INSTREAM STRUCTURES

When developing project budgets, it is important to have a rough estimate of how much an instream structure will cost. Structures can be divided into two categories: simple and complex. Simple structures such as a single secured “digger log” or single straight or diagonal “log weir” is valued at around \$750. A complex structure such as a “spider log” consisting of at least three logs that are 12 inches in diameter and 10 feet in length has a standard cost of \$2,250. The minimum recommended size for logs used in structures is 12 inches in diameter and 10 feet in length. Boulder structures such as “weirs” have a standard cost of \$2,000. Boulder wing deflectors are valued at \$2,250 with an emphasis that the apex boulders be a minimum of 3 feet in diameter. The standard cost of boulder clusters is \$250 per boulder (CDFG 2000, p. C19). It is important to emphasize that these costs are to be used only as a guideline. For example, complex structures involving multiple large logs and boulders are more costly. Also contributing to

the cost are the ease of access for crews and heavy equipment, local labor, equipment and material rates, and the distance over which logs, rootwads and boulders must be transported. Project proponents should itemize these increased costs in their proposals to assure proper funding consideration. A sample project proposal is provided in Appendix 1 of this paper to illustrate how project costs are generally reported.

There can be many different factors to consider when developing labor, materials and equipment costs for a project. One way to make up for increased costs for one aspect of the project is to find a way to decrease the costs in another category.

Labor: Labor rates cited in proposals in California are typically \$12 to \$14 per hour for laborers and \$15 to \$20 per hour for crew supervisors. Who is chosen to perform the labor on a project will have a large impact on the cost. Organizations such as the California Conservation Corps (CCC) and Americorps are made up of young people who have a strong “esprit de corps” and a demonstrated ability to operate effectively in remote hike-in locations. This can make up for some of the increased accessibility and transport costs associated with remote locations. Additionally, groups that involve high percentages of volunteer labor or other in-kind matches improve the cost-effectiveness of operating in very remote or inaccessible locations.

Materials: Of note is the newly developing technique of falling or placing large unanchored trees into streams. There have been some successes and indications of greater cost-effectiveness than with hand-crew intensive structure building. No standard value has been established yet for placing whole trees. Instream structures typically require 30 feet of minimum 5/8 inch galvanized steel cable at \$1.25 per foot, or threaded rod at \$1.30 per foot. There will be additional costs for clamps (for the cable) and nuts and washer plates (for the threaded

rod). Epoxy tubes for rock fastening are \$25 per tube. Structures built under current guidelines are expected to last a minimum of 10 years. When structures are built using redwood and 5/8 or 3/4 inch cable, their lifetime is substantially longer.

Equipment: Some standard heavy equipment rental rates are as follows: backhoe \$70 per hour, excavator \$80 to \$120 per hour, dump truck \$50 per hour, Cat with winch \$80 to \$90 per hour. Construction of instream structures also requires some specialized tools that allow hand crews to move and fasten large logs and boulders in remote locations. Heavy-duty hand-operated winches called grip-hoists cost over \$1,000, chainsaw-operated winches cost \$600, gas-operated rock tools cost \$900, and gas-operated wood drills and chainsaws each cost \$600. Typically project proponents charge a rental fee that allows them to rent tools or maintain the ones that they own. High-quality tools in good operating condition are essential for the productivity of the work crew.

In California, equipment that costs more than \$500 cannot be bought using a state contract. This can be quite a hardship for groups doing restoration work, though, because the specialized tools needed to accomplish the work are expensive to buy and to maintain. The National Marine Fisheries Service (NMFS) should consider a funding mechanism with which to “seed” motivated watershed groups, volunteers, and perhaps startup restoration contractors with the means to purchase these expensive specialized tools. This would allow many very dedicated individuals and groups to pursue more effectively the work they are already doing without compensation.

FUNDING FOR INSTREAM STRUCTURES

The CDFG Fishery Restoration Grants Program funds millions of dollars of restoration projects each year. The program has

been in existence for about 20 years, which have been a period of constant refinement of the definition of a “good” restoration project proposal. Submitting a good proposal requires a thorough knowledge of both the CDFG RFP (CDFG 2000) and the California Salmonid Stream Habitat Restoration Manual (Flosi *et al.* 1998). The CDFG holds workshops at various locations around the state to help advise potential project proponents on the development of a successful project proposal.

When under consideration for funding, proposals are scored according to a protocol that has been developed in order to make the decision process as objective as possible. One important aspect of a successful proposal is the amount of matching funding that has been obtained for the project. The February 11, 2000 CDFG *RFP* defines “hard match” as materials, equipment, and cash. “Soft match” includes the salaries of permanent funded government employees and office space. While project planning costs are not considered hard match, they do, in the case of watershed plans, demonstrate local stakeholder buy-in and a level of science-based prioritization. Planning efforts can make a restoration project more highly desirable as a candidate for funding.

Once projects are complete, CDFG staff evaluates them to ensure that their objectives have been met. A standard evaluation form is used, which asks the evaluator to rank the project’s success according to specific criteria. For example, if the new structure was supposed to make a pool, the evaluation asks whether there is now a pool at that location and how deep the pool is.

CALCULATING LARGER-SCALE COSTS

For recovery planning and funding considerations, it is very important to consider the aggregation of restoration costs over unit areas such as tributaries, sub-basins, watersheds, and evolutionarily signif-

icant units (ESUs). No accurate large-scale cost projections have yet been developed. However, CDFG Associate Fishery Biologist Barry Collins is charged with monitoring and data management and is reported to be developing an analysis along these lines. It is also possible to get some idea of average costs in various geographic areas by reviewing the project proposals that are considered for funding every year by CDFG. For instream structures, I found application rates ranging from 15 to 40 structures per mile, with a cost of \$2,200 to \$2,500 for a complex structure.

The streams in which we are working are generally first, second and third order, in the upper regions of the watersheds. These are the refuges – the only places where salmon and steelhead have adequate water temperature and stream structure complexity to spawn. Because these streams have relatively low flow, the structures that we install are fairly small. A complex structure might cost around \$2,250. If 30 structures are installed per mile, the total cost will be \$67,500 per mile. For simple structures the cost might be as low as \$3,360 to \$7,000 per mile. Projects typically contain a mix of simple and complex structures, so the cost will vary accordingly. There is no demonstrated cost-per-unit reduction when building increased numbers of structures.

In order to develop estimates of costs for larger geographic areas, there are a number of large-scale data sources that can be used. The CDFG, in cooperation with the CCC, Americorps, and members of individual watershed groups, has completed stream habitat surveys covering thousands of miles. The surveys involve assessing the habitat type along each reach of the stream, which includes measuring the flood-prone area, the large woody debris shade cover rating, and the Rosgen channel type. From these parameters, it is possible to determine which instream structures are appropriate for each

reach. In addition, timber companies have performed both instream and road surveys. These surveys indicate stream-reach miles that are in need of habitat improvement and, in some cases, the instream structures that would be appropriate.

Experience can also be a valuable tool in prescribing stream treatments. A fisheries biologist or restoration contractor who has a good knowledge of the stream and of previous restoration efforts can look at the stream and recommend the necessary structures. This kind of judgment based on life experience can be invaluable and can allow restoration work to proceed even in the absence of detailed stream surveys, which can be very expensive.

Of great importance is that current instream and upslope watershed conditions be addressed when instream treatments are prescribed. It makes little sense to build instream structures in 80° F water, in streams heavily overburdened with untreated sediment delivery sources, or above migration barriers. I have seen streams so heavily overburdened with gravel that structures are completely ineffective in scouring pools with depths of more than one foot. Sediment loads can be so heavy that they break apart 5/8-inch galvanized cable, which will destroy structures. Structures installed under these conditions are clearly a waste of money. Furthermore, the future land use in the watershed must be taken into account. It is futile to try to improve habitat by placing instream structures in an area that will be clear-cut in a year or two.

It would be very helpful if NMFS in consultation with State fish and game departments would develop a prioritization system for projects. This system could be used to direct immediate funding towards maintaining seriously threatened remnant wild salmon and steelhead populations. The habitat protected using this money would be along the lines of “refugia” or “habitat

anchors.” Ideally, soundly constructed instream structures should be designed as part of a comprehensive sub-basin restoration plan that treats controllable sediment sources along with restoring riparian vegetation, and includes a monitoring plan to demonstrate habitat response and project effectiveness.

COST-EFFECTIVENESS OF INSTREAM STRUCTURES

There are a number of ways to further improve the value and cost-effectiveness of instream structures. Some suggestions follow.

- *Ensure that prescriptions are the result of a survey or the recommendation of a trained and experienced habitat specialist or contractor.*
- *Streamline the permitting process.* We have seen some situations where an opportunity to do instream work has been lost due to an inability to obtain the necessary environmental permits. During the time it takes to go through the permitting process, projects can become less feasible and considerably more expensive. If coordination between state and federal agencies were improved, the length of the permitting process could be dramatically reduced.
- *Try to be sensitive to contractors and the work season.* Short work seasons make it more difficult for contractors to make a living: they are unable to support themselves for the rest of the year and are forced to give up restoration work in favor of a full-time job.
- *Use proven standardized fastening techniques employing sound, properly sized logs, rootwads, and boulders.*
- *Incorporate instream projects with upslope sediment treatments, timber harvest*

plans, or bank stabilization projects. This makes it possible to take advantage of the heavy equipment that will already be at the site for the other work being accomplished in that location. Using heavy equipment for instream structures can be vastly more cost-effective than building the same structures “by hand.”

- *Provide funding for structure maintenance.* This will extend the life of instream structures and improve their function. Upgrading structures using new materials can be particularly effective. For example, 1/2-inch cable can be replaced with 5/8-inch cable, and new and improved epoxy glues can be used.
- *Assist watershed groups and volunteer efforts.* It would be very beneficial to aid contractors in purchasing needed expensive specialized restoration equipment with some sort of start-up grant.
- *Fund regional technical training and conferences.* This can be accomplished through such organizations as the Salmonid Restoration Federation, For the Sake of the Salmon, Resource Conservation Districts, and local watershed groups. Training and conferences create opportunities for the sharing of valuable experience, so that new workers do not repeat the mistakes made in the past.

DISCUSSION

Those promoting stream restoration do not say that restoration alone will recover salmonids. Recovery will come from a comprehensive package that addresses limiting factors through regulatory reform and protection, including acquisition of key habitat and provision for adequate stream flows. Fishermen and fishing organizations such as Trout Unlimited have great potential as allies, workers, and proponents of projects

to recover the once-magnificent West Coast salmon and steelhead runs. It is important to recognize that those people working to restore salmonid populations are highly motivated and in tune with current science.

Their dedication is demonstrated by the fact that they consistently volunteer large amounts of time towards the goal of salmon and steelhead recovery.

REFERENCES

California Department of Fish and Game, Watershed Restoration Branch. Fishery Restoration Grants Program. February 2000. *Request for Proposals (RFP) — RFP2000*.

[Can be obtained online at <http://www.dfg.ca.gov/nafwb.fishgrant.html>.]

Flosi, Gary *et al.* 1998. *California Salmonid Stream Habitat Restoration Manual, Third Edition*. California Department of Fish and Game, Inland Fisheries Division.

[Can be obtained online at <http://www.dfg.ca.gov/nafwb.manual.html>.]

Seddell, James R. *et al.* 1998. Chapter 3: What we know about large trees that fall into streams and rivers. *In*: Maser, Chris *et al.* *From the Forest to the Sea: A Story of Fallen Trees*. Gen. Tech. Rep. PNW-GTR-229. USDA Forest Service, Pacific Northwest Research Station, Portland, Oregon.

Appendix 1. Example Project

Instream Component South Fork Garcia River Watershed Restoration Project

Background

While the highest priority focus of Trout Unlimited's South Fork Garcia Project is upslope erosion control, there is a good opportunity to improve instream habitat. Mendocino Redwood Company (MRC), as part of a Timber Harvest Plan (THP) requirement, has agreed to put to bed a section of haul road that runs along the South Fork. Once this road is decommissioned, future access for heavy equipment will not be possible. MRC has agreed to provide equipment, manpower, and materials match in the form of a D7 with a winch, delivery of redwood root wads, and an additional donation of 5000 board feet of high-quality > 10" redwood logs to be used for structures.

The South Fork Garcia is a good candidate for instream structure placement. It is one of only four Garcia River tributaries where coho salmon have been documented in the last 10 years (2 adult coho were found during a 1996 spawner survey). According to a Louisiana Pacific (LP) 1996 survey, pools made up only 22.4% of the stream reach and no pools measured deeper than 3 feet. LP's 1995 temperature data collected from mid-July to early October indicated a mean summer temperature of 59° F (15° C), embeddedness of 14.5%, and canopy of 90%. The gradient in the proposed project reach is 1–3%.

Proposed Land Use

MRC owns approximately 90% of the sub-basin and is managing for commercial timber production. With the commitment of MRC to address and repair sediment sources, both THP-linked with their funds and PWA-identified sites with public-private match, the

outlook for success is good. MRC's commitment to educate its licensed timber operators by Pacific Watershed Associates in the classroom and the field represents a breakthrough for local watershed efforts. Future timber harvesting will likely be moderated by constraints of the ESA coho listing, the Clean Water Act (TMDL), and Sustained Yield Plan/Habitat Conservation Plan provisions as developed.

Objective

To improve summer rearing and winter spawning and rearing habitat for Coho salmon and steelhead by installing instream habitat structures.

Location

The South Fork Garcia is found on the Gualala U.S. Geological Survey 7.5-minute topographic map. The Planning Unit is 113.70012. It is further identified by Township 12 North and Range 15 West, Sections 29–34, and Township 11 N, R 15 Sections 3–4. The proposed work sites are located on South Fork Garcia River Map A. Fifteen suitable sites were identified and tagged in a Trout Unlimited (TU) October 1998 survey. Ten sites will be chosen depending upon the size and shape of logs and rootwads delivered by MRC. Site locations have been measured to the foot by belt chain and tagged by ribbon. All work will be photo-documented for the final report.

Project Description

Ten structures (six complex and four simple) are proposed. They will include spider logs (with and without rootwads), downstream-V log weirs with and without rootwads, diagonal and straight log weirs with

rootwads, Hewitt ramp, and digger logs. Standard pinning and cabling techniques will be employed as described in the *California Salmonid Stream Habitat Restoration Manual* [see title question above] (1998) using 5/8" galvanized cable and threaded rebar. The high quality of the redwood materials being donated by MRC should ensure long project life. TU staff and volunteers will perform maintenance and monitoring.

Permits

DFG 1601/1603 Streambed Alteration Agreement. A signed landowner access agreement is attached to the overall proposal.

Scheduling

Work will take place during summer low-flow period 1999.

Table A1. Estimated budget: South Fork Garcia River instream structure component

	Number of Hours	Hourly Rate	Amount Requested	Amount Cost Share	Project Total
PERSONNEL COSTS					
Project Leader	60	\$15	\$0	\$900	\$900
Volunteer Laborers	60	\$10.00	\$0	\$600	\$600
TOTAL PERSONNEL COSTS			\$0	\$1,500	\$1,500
MATERIALS AND SUPPLIES					
5500* board ft. fresh redwood logs @ \$570/1000 bd.ft			\$0	\$3,135	\$3,135
10 redwood rootwads @\$50			\$0	\$500	\$500
500 feet 5/8" galvanized cable @ 1.10/ft			\$550	\$0	\$550
100 5/8" cable clips @ 1.60			\$160	\$0	\$160
100 feet threaded rebar @ 1.50/ft			\$150	\$0	\$150
Plates and anchor nuts for rebar			\$100	\$0	\$100
Tool rental: 2 grip hoists, high lift jack, gas-powered wood drill, webbing, bars, cable cutter, wrenches, gas hammer drill, axe, safety gear			\$0	\$400	\$400
Chainsaw at \$30/day			\$240	\$0	\$240
Wood and rock drill bits			\$100	\$0	\$100
3 epoxy tubes @ \$25			\$0	\$75	\$75
TOTAL MATERIALS AND SUPPLIES			\$1,300	\$4,110	\$5,410
OPERATING EXPENSES					
16 hours D7 with winch @ \$70			\$0	\$1,120	\$1,120

Table A1. Estimated budget: South Fork Garcia River instream structure component (cont'd.)

	Amount Requested	Amount Cost Share	Project Total
8 hours dump truck @\$50	\$0	\$400	\$400
Subcontractor - cable rigger 50 hrs. @30/hr	\$1,500	\$0	\$1,500
Liability insurance	\$1,150	\$0	\$1,150
Transportation 450 miles @.24	\$108	\$0	\$108
Photographic supplies	\$30	\$0	\$30
Printing, duplicating, and postage	\$30	\$0	\$30
Telephone	\$20	\$0	\$20
TOTAL OPERATING EXPENSES	\$2,838	\$1,520	\$4,358
Administrative overhead @ 10%	\$280	\$0	\$280
TOTAL ESTIMATED BUDGET	\$4,138	\$7,130	\$11,548
PERCENT COST SHARE: 61.7%			

Figure A1. South Fork Garcia River proposed instream work survey # TU 981 (surveyed October 1998)

Numbers refer to feet measured from confluence of Fleming Creek and the South Fork.

0 - Confluence of Fleming Creek

285 - Channel Maintenance Site No. 1 — Modify jam by removing rootwads with Cat winch and utilize them in constructing an instream structure 100 feet downstream. (Note: these rootwads appear to have dislodged from a bank armoring site upstream. Additionally there are signs of previous barrier removal work at this jam site.)

380 - Instream Structure site No. 1 — Cable rootwads removed from jam to plunge pool redwood log.

520 - Structure site No. 2 — Using Cat winch — pull rootwads to armor road bank. Add rootwads and rock to armor bank and create pool habitat. Cut downed alders to allow stream flow away from eroding roadbank.

800 - Structure site No. 3 — Cable additional redwood log/rootwads to existing cross-channel plunge pool log.

963 - Structure site No. 4 — Cable two additional logs to improve plunge pool effect.

1110 - Structure Site No. 5 — Drop rootwads from roadside bank. Cable to redwood logs and cable/epoxy to rock.

1430 - Confluence of Little South Fork. Culvert to be replaced by MRC with railcar bridge. Save large logs for instream use.

1630 - Channel Maintenance Site No. 2 — Clear brush on roadside bank. Reverse pull redwood root to open channel.

2200 - Structure Site No. 6 — Pivot log and cable to existing cross-channel log to enhance plunge pool.

2280 - Structure Site No. 7 — Using Cat winch, chainsaw, and cable, configure blowdown redwoods into downstream V weir.

2600 - Log Jam — Small jam-fish passage OK; check again in 1999.

3150 - Structure Site No. 8 — Construct demonstration “Hewitt ramp” using redwood logs, planks, and large nails.

3212 - Structure Site No. 9 — Deliver rootwads from road to scour pool habitat.

Note: Confer with MRC forester about available redwood logs for structures in this reach.

3360 - Structure site No. 10 — Build spider log structure.

5070 - Structure Site No. 11 — Pull rootwad and cable to redwood log. Add additional rootwads from road.

5200 – 5800 - Four additional sites here — check with MRC on rootwad availability.

Note: Channel Maintenance sites are not proposed for funding under SB 271.

